

# TRANSACTIONS of the AMERICAN FISHERIES SOCIETY

April 1960

VOLUME 89

NUMBER 2

## The Bait Shrimp Fishery of Galveston Bay, Texas

EDWARD CHIN

U. S. Bureau of Commercial Fisheries, Biological Laboratory  
Galveston, Texas

### ABSTRACT

From June 1957 through May 1959 the bait shrimp fishery in Galveston Bay, Texas, was studied to determine the species composition and the magnitude of the catch. Total production for the 2-year period amounted to over 676,000 pounds, having a retail value of almost \$779,000. The fishery is chiefly in summer and fall; over 90 percent of the production occurred from May through October. Brown shrimp (*Penaeus aztecus*) and white shrimp (*Penaeus setiferus*) were the major species taken. Occurring sporadically were pink shrimp (*Penaeus duorarum*), seabobs (*Xiphopeneus krøyeri*), and *Trachypeneus* sp. The median weight of brown shrimp in samples obtained from the fishery was almost static at 2.0 to 4.0 grams and did not exceed 5.0 grams. The median weight of white shrimp fluctuated and ranged up to 15.5 grams. Young white shrimp apparently enter the bay later in the year than brown shrimp, stay longer, and grow to a larger size before leaving for offshore waters. Length-weight relationships for brown and white shrimp were determined.

### INTRODUCTION

Several species of commercially important penæid shrimp found in the Gulf of Mexico are commonly used as bait by sport fishermen. The desirability of shrimp for this purpose has given rise to a bait shrimp industry of considerable importance in some areas. De Sylva (1954) found that over 38 million shrimp entered the bait industry on the northeast coast of Florida in 1953. On the west coast of Florida, Woodburn *et al.* (1957) reported almost 59 million shrimp taken for bait in 1955. In a test area in Alabama, Loesch (1957) noted over 17,000 pounds of shrimp taken by bait fishermen in 66 days, and since few of the shrimp were larger than 50 count (50 individuals per pound), this take represents well over 850,000 shrimp. Detailed information concerning the bait shrimp industry in other areas of the Gulf is not readily available. From June 1957 through May 1959 a study was conducted in the Galveston Bay area of Texas to determine the magnitude of the bait shrimp fishery and the size and species of shrimp taken.

Penæid shrimp found along the Texas coast by Gunter (1950) included the white shrimp (*Penaeus setiferus*), the brown shrimp (*Penaeus aztecus*), the pink shrimp (*Penaeus duorarum*), the seabob (*Xiphopeneus krøyeri*), and *Trachypeneus constrictus*. The life history of the white shrimp has been described by Viosca (1920), Weymouth, Lindner, and Anderson (1933), Burkenroad (1934, 1939), Pearson (1939), and others. Spawning takes place in the open waters of the Gulf from spring to fall. The eggs are demersal and hatch approximately 24 hours after being spawned. The larvæ and post-larvæ are planktonic for about 3 weeks, during which time they move from the saline offshore waters of the spawning grounds to the brackish inshore waters where they adopt a benthic existence. Four to ten weeks of rapid growth are spent in these inside waters. As the shrimp increase in size and mature, they gradually move back to the open waters of the Gulf, presumably to offshore spawning grounds. Less is known about the biology of the other species, but brown and pink shrimp are assumed to have similar life histories.

## METHODS

*Collection of statistics*

A survey in November 1956 revealed about 200 bait stands located on Galveston Bay (Figure 1). In this paper reference to Galveston Bay includes the bay proper, Trinity Bay, East Bay, and West Bay. During the study period about 80 dealers obtained and supplied shrimp for the local bait industry. Bait stands were so widely scattered throughout the area that it was difficult to interview each dealer oftener than every 2 or 3 days and since few maintained records of their catch, much of the information collected was based on their memory and estimates. There are presently few restrictions on bait shrimping activities in the bay, and there was reluctance on the part of some dealers to disclose catch statistics. The production figures obtained, therefore, are considered minimal.

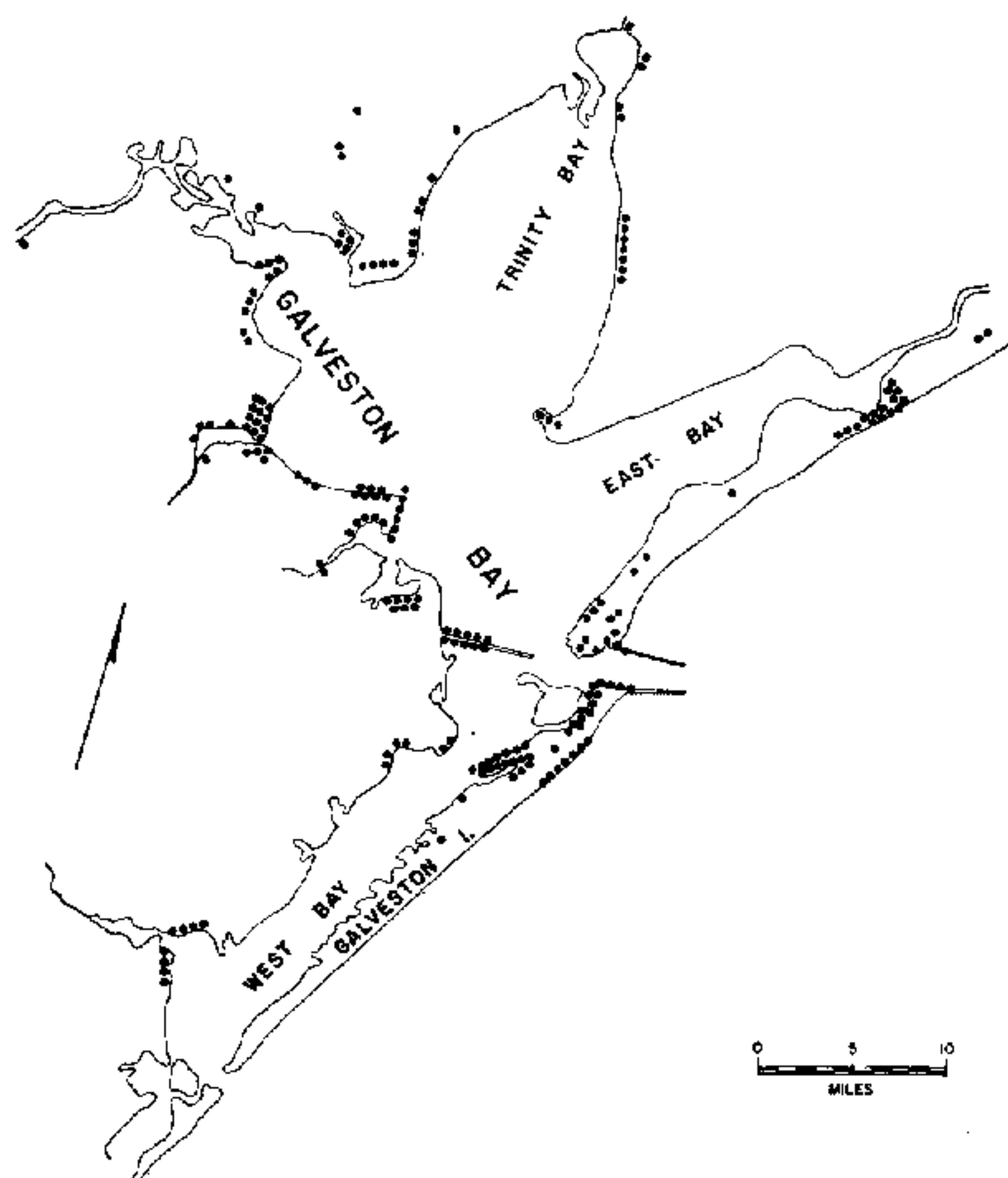


FIGURE 1.—Locations of bait stands in Galveston Bay area.

In order to combine production figures of live and dead bait, it was necessary to determine the weight of a quart of shrimp. Live bait is sold by the pint or quart at \$2.00 per quart in summer when shrimp are abundant and \$3.00 per quart in winter when they are scarce. On the other hand, dead bait is sold by the pound at 50 to 60 cents per pound. On the basis of 15 samples, 1 quart of live shrimp weighs approximately 1.5 pounds.

*Collection of biological samples*

Samples of live shrimp were purchased periodically from dealers to determine the size and species composition of shrimp handled. Bait shrimp in Galveston Bay are taken mainly with small otter trawls ranging from 10 to 25 feet along the cork line and upwards of 25 feet in length. Mesh sizes range from  $1\frac{3}{8}$ - to  $1\frac{3}{4}$ -inch stretched measure. The gear and methods used by the bait industry are described in greater detail by Inglis and Chin (1959).

*Methods of measurement*

Several methods of measuring shrimp have been employed. Total length (from tip of rostrum to tip of telson) regarded by Weymouth, Lindner, and Anderson (1933) as the most reliable measure of size of white shrimp is commonly used. Burkenroad (1934), however, suggested that several factors reduced the reliability of total length as a measure of size. He stated that as white shrimp increased in size, the relative length of the rostrum decreased and that white shrimp along the Atlantic coast had a longer rostrum than those in the Gulf of Mexico. Other difficulties with the use of total length were noted by Cole and Mistakidis (1953). It is not uncommon to find the rostrum damaged or partially regenerated. Furthermore, shrimp often assume a flexed position upon preservation and subsequent efforts to measure total length of preserved specimens usually result in separating the head and tail portions.

Most of the preceding objections to total length do not apply to carapace length, a measurement used in some studies. The length of the carapace is generally measured from the lateral base of the eye notch to the median dorsal posterior edge. Carapace measurements require considerable precision since they seldom exceed 65 millimeters in penaeid shrimp. Cole and Mistakidis (1953) suggest an accuracy of 0.25 millimeter in their studies on European prawns and shrimps. A further consideration in the use of carapace length is that it may fail to reflect an increase in weight when the latter is caused by increase in girth. Burkenroad (1950) noted that a number of molts after the postmysis stage in *Penaeus duorarum* resulted in increase of stoutness rather than length.

By inference, some workers have suggested



the desirability of total weight as a measure of size. Certain disadvantages in the use of total weight are obvious. Material preserved in alcohol or formalin loses weight significantly and the use of balances on board small vessels is difficult. In the present study it was also found to be impractical to weigh shrimp less than 30 millimeters in total length on moderately sensitive balances. Nevertheless, total weight was used for several reasons. We were not subject to any of the limitations noted above; preservation was unnecessary, shrimp were weighed in the laboratory, and few were less than 30 millimeters in length. With the direct-reading balances now available, shrimp can be weighed with great rapidity and accuracy. For example, one person, using a Mettler balance (Type K-7, precision,  $\pm 0.03$  gram), measured and recorded the weights of 100 individuals in slightly more than 13 minutes. Several weighings of the same lot of shrimp showed almost identical results. Furthermore, length measurements, when applied to management of most fisheries, require ultimate conversion to appropriate weights and therefore, when practical, measuring directly in terms of weight is preferable to indices based on morphometric relationships.

To convert weights to lengths, length-weight relationships for white and brown shrimp were derived, using the least squares method. Log-log plots of lengths and weights from 976 white shrimp, including 553 females and 423 males, and 802 brown shrimp, including 502 females and 300 males, showed that for both species the relationship was best expressed by the typical length-weight equation:

$$W = aL^b$$

or,

$$\log W = \log a + (b) (\log L)$$

where  $W$  = total weight in grams,  $L$  = total length in millimeters, and  $a$  and  $b$  are constants.

Length-weight relationships for both sexes were almost identical within each species. Between species, however, brown shrimp are somewhat heavier than white shrimp at comparable lengths. The following equations<sup>1</sup> for

<sup>1</sup>Since these data were obtained, the length-weight relationship for white shrimp has been published by Anderson and Lindner (1958). Mean weights at various lengths shown in their Table 4 were compared to weights at the same lengths calculated using the above equation. Results compare favorably up to a length of 143 millimeters. From 148 to 193

each species, males and females combined, are shown graphically in Figure 2:

Brown shrimp:

$$\log W = -5.483 + (3.190) (\log L)$$

White shrimp:

$$\log W = -5.289 + (3.075) (\log L)$$

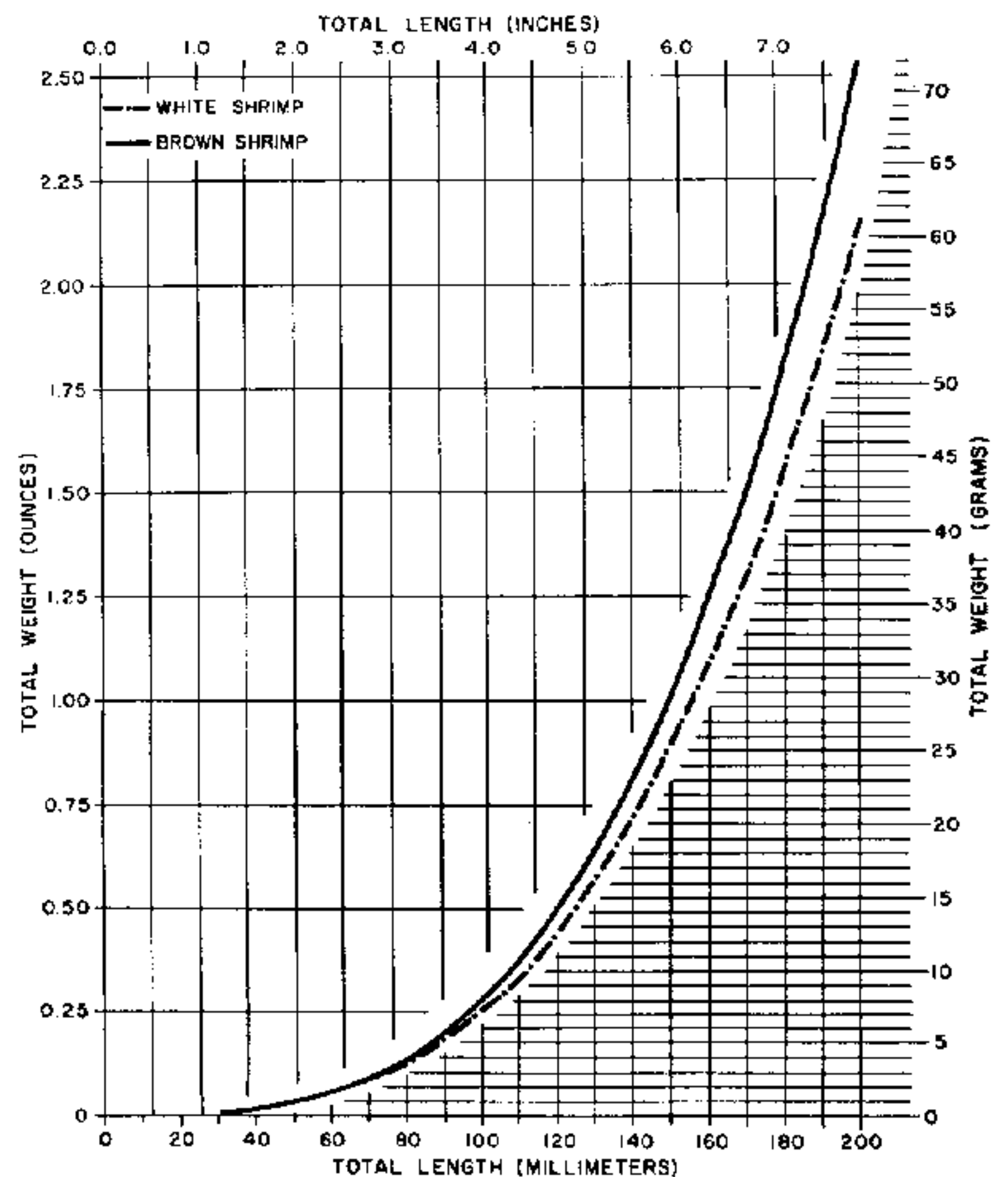


FIGURE 2.—Length-weight relationships for brown and white shrimp.

#### TOTAL PRODUCTION

Total production of bait shrimp for the 2-year period from June 1957 through May 1959 amounted to over 676,000 pounds with a retail value of almost \$779,000. As shown in Figure 3, production was considerably higher during the second year which may have reflected either a greater volume of shrimp handled by the industry or a greater efficiency at collecting statistics. The lower production during the first year, especially in July, was due partially to extensive damage to bait boats and camps caused by hurricanes Audrey and Bertha. Production trends, nevertheless, were similar in both years. In winter there is an apparent scarcity of shrimp in the bay and the fishery is relatively inactive. In

millimeters their mean weights ranged from 1.5 to 6.3 grams higher and at their maximum length listed (198 millimeters) the average weight was 10.7 grams higher than the calculated value. Differences above 148 millimeters may be due to differences in degree of maturity.

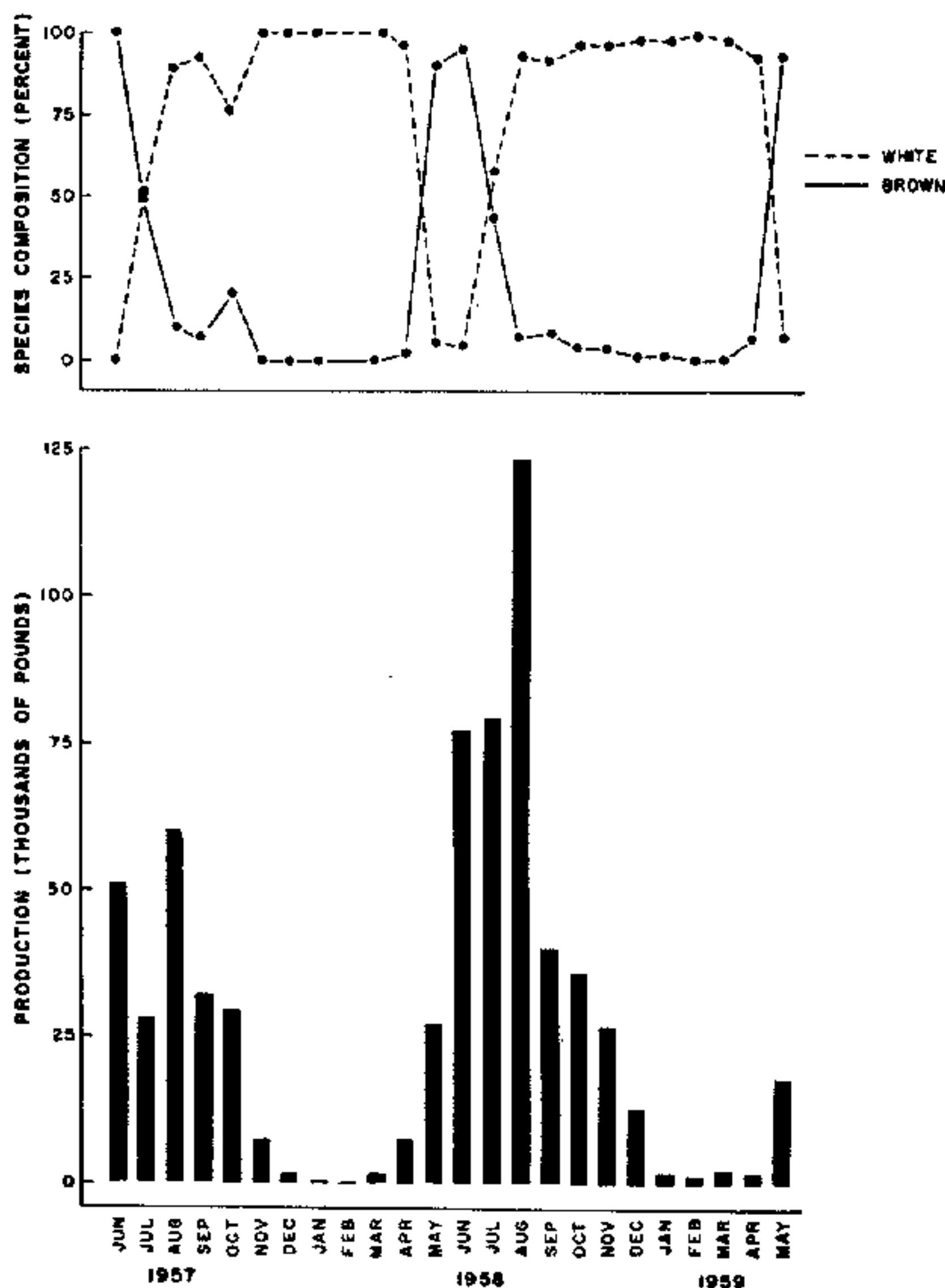


FIGURE 3.—Monthly production of bait shrimp in Galveston Bay area and percentage species composition by weight. Minor species not shown.

spring the bait catch begins to increase and in May rises sharply when the young of the year are recruited into the fishery. Production reaches a peak in August and thereafter declines rapidly until November when it is 15 to 20 percent of the August catch.

Practically the entire catch was obtained within Galveston Bay. In the winter shrimp are occasionally brought in from other areas in aerated tank trucks. During the winter of 1957-1958 less than 5,000 pounds were transported from the Sabine area, about 60 miles to the east. The following winter approximately 2,000 pounds were brought in from the same area and almost 1,400 pounds from the Port Aransas area, about 200 miles to the south.

A comparison of shrimp production by the bait fishery with that by the commercial fishery<sup>2</sup> in Galveston Bay is shown in Table 1. Data on the commercial fishery were obtained from the monthly summaries of shrimp sta-

<sup>2</sup>In spite of the obvious commercial aspects involved, the bait fishery is considered apart from the commercial fishery which catches shrimp for use as food.

tistics collected by the U. S. Bureau of Commercial Fisheries and available, thus far, through April 1959. Commercial production trends were necessarily affected by state regulations in force during the study. The bay was closed to commercial fishing from December 15 to March 1 and from July 15 to August 31. The bait fishery, on the other hand, is not subjected to any seasonal limitations.

During winter when the bait fishery was inactive, the commercial fishery was restricted by regulations. Unlike the bait catch which rose in May, the commercial catch was almost non-existent during spring even though the bay was opened to commercial trawling. As shown by Figure 4, this difference was probably due to the preponderance of young shrimp too small for the commercial fishery but suitable for the bait fishery. During the study there was no minimum size limit in Texas for shrimp used as bait. For commercial purposes the minimum size limit was in terms of no more than 39 shrimp per pound. From July 15 to August 31 the bay was again closed to commercial fishing; thus, through a combination of circumstances the bait catch from May through August was considerably greater than the commercial catch.

The commercial catch first assumes sizeable proportions in August. The regulations for the commercial fishery are interpreted locally as permitting fishing on August 31 and the catch landed on the last day of August in each year was approximately 80 percent by weight of the bait catch for the entire month. From September through November in 1957 and through December in 1958, production by the commercial fishery far exceeded that by the bait fishery.

#### SPECIES AND SIZE COMPOSITION

Only a few samples of the relatively small amount of shrimp transported from other areas were obtained and the data are not included in this report. The following discussion is limited to the species and size composition of local shrimp entering the bait industry. During the 2-year study 170 samples containing a total of 16,224 shrimp were examined. If the samples are assumed to be representative of the populations of shrimp in the bay, that is, within the limitations of gear selection, the seasonal occurrence and sizes of the various species can be compared.

TABLE 1.—Shrimp production by bait and commercial fisheries in Galveston Bay, 1957-1959  
[Shrimp transported from other areas omitted.]

Month	Live bait		Dead bait		Total bait catch		Commercial catch
	Pounds <sup>1</sup>	Retail value	Pounds	Retail value	Pounds	Retail value	Pounds
June 1957.....	41,221	\$54,962	9,850	\$ 5,275	51,071	\$60,237	(none)
July.....	22,391	29,854	5,667	3,161	28,058	33,015	(none)
August.....	37,790	50,386	22,417	11,208	60,207	61,594	46,730
September.....	21,915	29,220	10,465	6,059	32,380	35,279	533,875
October.....	22,785	30,380	6,913	3,563	29,698	33,943	160,636
November.....	4,910	6,540	2,528	1,164	7,438	7,704	1,453
December.....	1,260	1,680	251	125	1,511	1,805	(none)
January 1958.....	324	648	(none)	—	324	648	(none)
February.....	120	40	(none)	—	120	40	(none)
March.....	1,193	2,255	428	215	1,621	2,470	(none)
April.....	6,086	7,542	1,483	841	7,569	8,383	(none)
May.....	23,850	36,998	3,494	1,746	27,344	38,744	(none)
June.....	64,397	94,083	13,149	6,573	77,546	100,656	(none)
July.....	63,791	96,188	15,385	8,774	79,176	104,962	(none)
August.....	53,817	81,236	69,627	40,595	123,444	121,831	99,616
September.....	18,305	24,406	21,758	11,608	40,063	36,014	422,735
October.....	22,101	29,468	13,949	7,142	36,050	36,610	163,276
November.....	20,574	27,432	6,049	3,092	26,623	30,524	73,374
December.....	10,832	14,442	1,838	919	12,670	15,361	33,257
January 1959.....	1,819	3,639	(none)	—	1,819	3,639	(none)
February.....	1,077	2,154	(none)	—	1,077	2,154	(none)
March.....	2,424	4,848	(none)	—	2,424	4,848	(none)
April.....	1,633	3,267	150	90	1,783	3,357	2,305
May.....	16,380	21,852	1,223	611	17,603	22,463	— <sup>2</sup>
Totals.....	460,995	\$653,520	206,624	\$112,761	667,619	\$766,281	—

<sup>1</sup>Converted from quarts by multiplying number of quarts by 1.5.  
<sup>2</sup>Information not yet available.

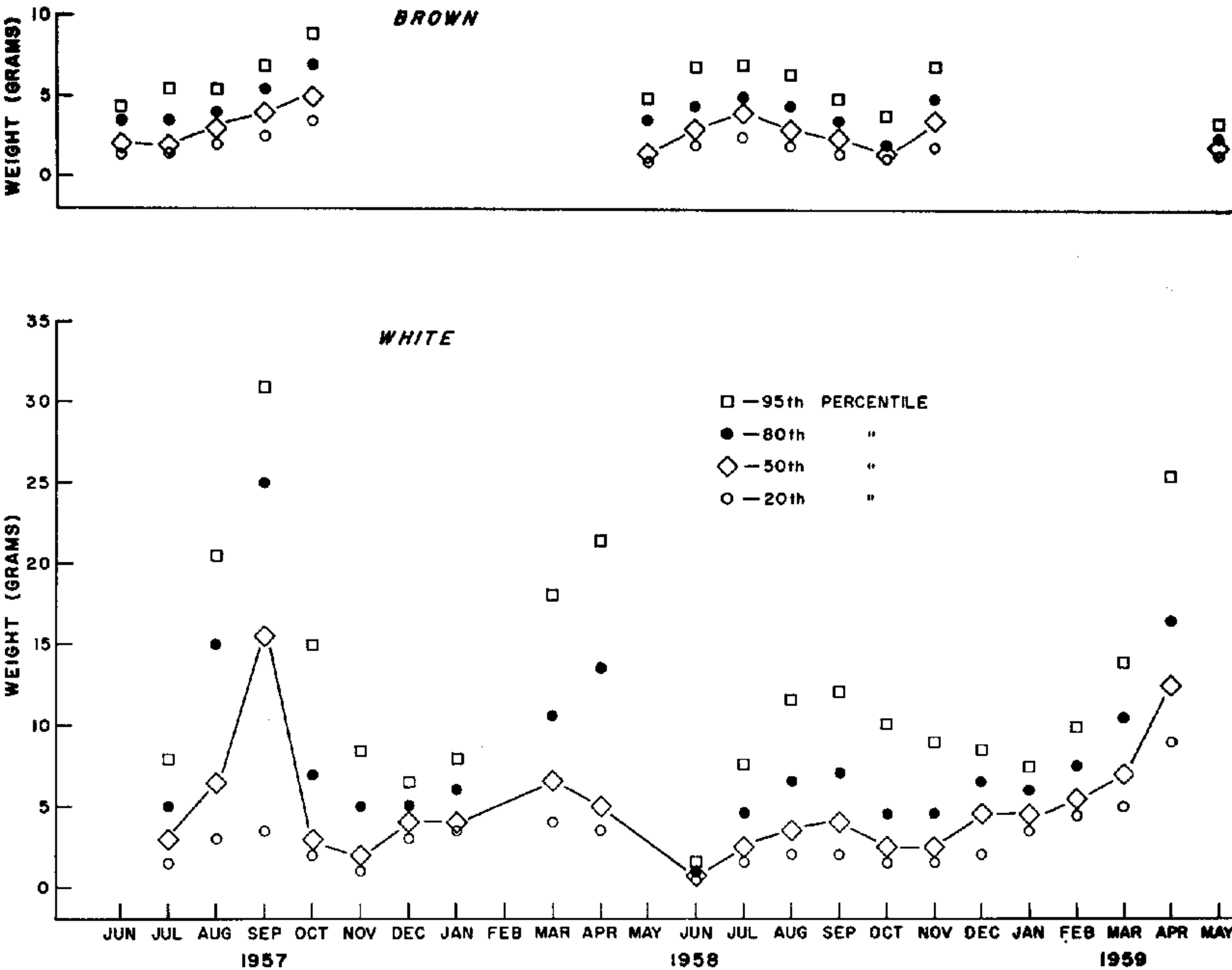


FIGURE 4.—Monthly changes in size composition of brown and white shrimp shown by percentiles.



Pink shrimp (*P. duorarum*), seabobs (*X. krøyeri*), and *Trachypeneus* sp. appeared sporadically in the samples. Pink shrimp, ranging from 1.0 to 13.9 grams, made up 9 percent of the samples in October 1957 and less than 1 percent in January and May 1958. Seabobs, ranging from 1.4 to 3.3 grams, amounted to less than 1 percent of the shrimp in July 1957 and in December 1958. *Trachypeneus* sp., ranging from 1.1 to 7.5 grams, formed 1 to 2 percent of the samples in December 1958 and February and March 1959.

Brown shrimp (*P. aztecus*) and white shrimp (*P. setiferus*) are the principal species supporting the local bait industry. Figures 3 and 5 show monthly changes in the percentage of each of the two species by weight and by number, respectively. *P. aztecus* seems to be important only from May through July. In May and June it is virtually the sole species supporting the bait industry. In July the catch is composed of brown and white shrimp in approximately equal proportions. In August, the peak month of production, about 90 percent of the catch by weight consists of white shrimp. During the following months the rapidly declining catch continues to be made up almost entirely of white shrimp. Brown shrimp do not again appear in numbers until April and May when the incoming young of the year give rise to increased activity by the fishery. Concomitantly, white shrimp disappear from the bay and do not reappear in the catch until June or July when a new crop is recruited into the fishery.

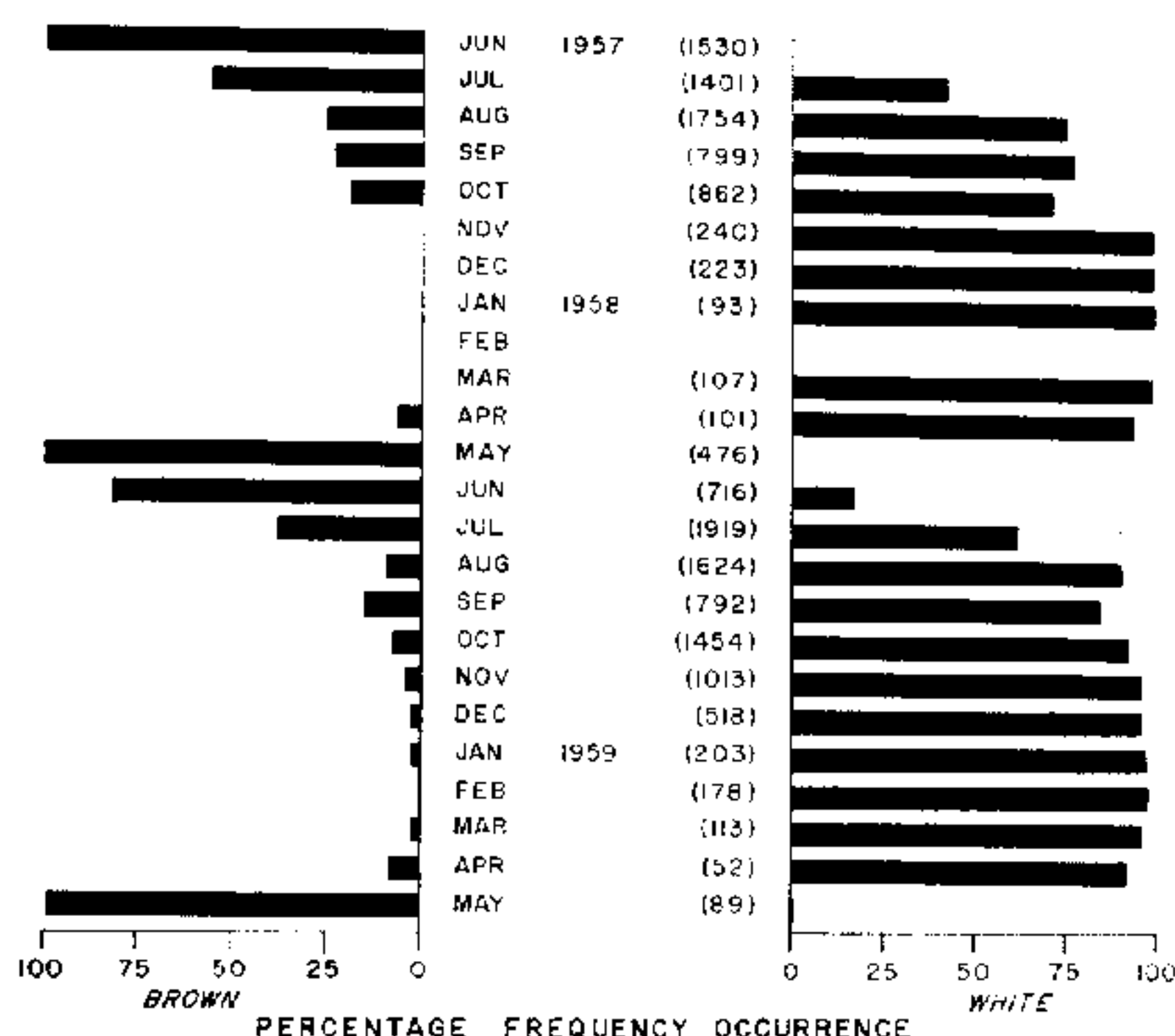


FIGURE 5.—Monthly changes in percentage frequency occurrence of brown and white shrimp obtained from Galveston Bay area. Figures in parentheses denote number of shrimp in samples.

The sizes of the two species differed markedly; brown shrimp ranged up to 23.5 grams, while white shrimp ranged up to 40.7 grams. The weight frequencies of shrimp in the samples were grouped by half-gram intervals so that resulting midpoints at 0.5, 1.0, 1.5 grams, etc., included shrimp that weighed 0.3 to 0.7 grams, 0.8 to 1.2 grams, 1.3 to 1.7 grams, etc. Figure 4 shows the 20th, 50th (median), 80th, and 95th percentiles of the weights of each species for each month. The data are not shown for months when the frequency occurrence of a species was 10 or less.

The median weight for brown shrimp was almost static at 2.0 to 4.0 grams and did not exceed 5.0 grams; the 95th percentile did not exceed 9.0 grams. Median weight for white shrimp fluctuated considerably more and reached 15.5 grams, and the 95th percentile ranged to 31.0 grams. The recurring abundance of shrimp less than 5.0 grams indicates that both species have an extensive spawning season. Changes in size and species composition are sufficiently consistent to show that young brown shrimp enter the estuarine waters earlier than white shrimp, presumably as the result of an earlier spawning season. Assuming that the two species have similar growth rates, the white shrimp must stay in the inshore waters longer since it grows to a larger size than the brown shrimp before disappearing from the bay.

These major differences in life history between the two species may be factors that have contributed to the decline of white shrimp and increase of brown shrimp over the past 20 years. Since the brown shrimp spends less time inside the bays, it is not as heavily exposed to the fishing effort of the bait industry as the white shrimp. Furthermore, by virtue of a short stay in the bay, the brown shrimp does not reach a commercially desirable size until it leaves the bay. In fact, the highest value of the 95th percentile for brown shrimp (9.0 grams) falls somewhat short of the minimum legal commercial size count of 39 shrimp per pound, which is equivalent to about 11.5 grams per shrimp. In contrast, the white shrimp reaches a commercially desirable size while inside the bay. In 9 of the 20 months in which white shrimp occurred more than 10 times in the samples, the 95th percentile was greater than the minimum legal commercial size. The white shrimp is thus subjected to exploitation by the commercial

fishery while in the bays, a fact which is strikingly demonstrated by the species composition of the commercial catch. Except for 664 pounds of brown shrimp caught in September 1957, the entire commercial catch from Galveston Bay shown in Table 1 consisted of white shrimp.

#### ACKNOWLEDGMENTS

The author wishes to express his appreciation to the Fishery Marketing Specialists of the Division of Industrial Research and Services, to various bait dealers for their cooperation and assistance, and to Anthony Inglis for mapping the locations of the bait stands.

#### LITERATURE CITED

- ANDERSON, W. W., AND M. J. LINDNER. 1958. Length-weight relation in the common or white shrimp, *Penaeus setiferus*. U. S. Fish and Wildl. Serv., Spec. Sci. Rept., Fish. No. 256, 13 pp.
- BURKENROAD, MARTIN D. 1934. The Penaeidea of Louisiana with a discussion of their world relationships. Bull. Amer. Mus. Nat. Hist., 68(2): 61-143.
- . 1939. Further observations on Penaeidae of the Northern Gulf of Mexico. Bull. Bing. Oceanog. Coll., 6(6): 1-62.
- . 1950. Measurement of the natural growth rates of decapod crustaceans. Proc. Gulf and Carib. Fish. Inst., 3: 25-26.
- COLE, H. A., AND M. N. MISTAKIDIS. 1953. A device for the quick and accurate measurement of carapace length in prawns and shrimps. Jour. du Conseil, 19(1): 77-79.
- DESILVA, DONALD P. 1954. The live bait shrimp fishery of the northeast coast of Florida. Florida St. Bd. Conserv., Tech. Ser. 11, 35 pp.
- GUNTER, GORDON. 1950. Seasonal population changes and distributions as related to salinity, of certain invertebrates of the Texas coast, including the commercial shrimp. Publ. Inst. Mar. Sci., 1(2): 7-51.
- INGLIS, A., AND E. CHIN. 1959. The bait shrimp industry of the Gulf of Mexico. U. S. Fish and Wildl. Serv., Fish. Leaflet 480, 14 pp.
- LOESCH, HAROLD. 1957. Observations on bait shrimp-ing activities in rivers north of Mobile Bay Causeway. Jour. Alabama Acad. Sci., 29: 36-43.
- PEARSON, JOHN C. 1939. The early life histories of some American Penaeidae, chiefly the commercial shrimp *Penaeus setiferus* (Linn.). Bull. U. S. Bur. Fish., 49(30): 1-73.
- VIOSCA, PERCY P., JR. 1920. Report of the Biologist. Louisiana Dept. Conserv., Fourth Bienn. Rept. 1918-1920: 120-130.
- WEYMOUTH, F. W., M. J. LINDNER, AND W. W. ANDERSON. 1933. Preliminary report on the life history of the common shrimp *Penaeus setiferus* (Linn.). Bull. U. S. Bur. Fish., 48(14): 1-26.
- WOODBURN, K. D., B. ELDRED, E. CLARK, R. F. HUTTON, AND R. M. INGLE. 1957. The live bait shrimp industry of the west coast of Florida (Cedar Key to Naples). Florida St. Bd. Cons., Tech. Ser. 21, 33 pp.